BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: The Common Mission Module - Description and Use - Case 730

DATE: June 14, 1968

FROM: D. Macchia

ABSTRACT

A spectrum of modules which can provide crew and mission support functions common to all manned missions are described. These modules are all derived from a single basic module design by the addition or deletion of standardized options during module assembly. The basic design requirements of such a basic module are presented along with typical modules and mission uses.

(NASA-CR-95477) THE COMMON MISSION MODULE - DESCRIPTION AND USE (Bellcomm, Inc.) 11 p

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MEMORANDUM FOR FILE

INTRODUCTION

A common mission module, which provides crew and mission support functions common to all long term manned missions, has been proposed[1] in order to avoid developing a number of different spacecraft. This module would include primary structure, atmospheric systems, environmental control, power, mission control, guidance and navigation, communications, module checkout panels, an airlock/storm shelter, living quarters, and life support systems. Propulsion and attitude control functions would be supplied by separate propulsion modules.[1]

Configuration studies were conducted[2] on this particular common module concept. A typical combined function module is shown in Figure 1. As a result of these studies, and examination of earth orbital, planetary, and lunar base mission requirements, various useful common module derivatives were identified. More generally, the common module and its derivatives are viewed as a spectrum of modules which can satisfy the requirements of all manned missions. The common module is not intended to be a fixed piece of hardware, even though such usage is feasible. Addition or deletion of standardized options during module assembly to tailor a module for different uses is part of the proposed concept. The common module is analagous to an automobile or truck with optional extras.

BASIC DESIGN REQUIREMENTS

Feasibility of a common module approach for all manned missions is dependent on the ability to satisfy basic design requirements which are a result of size and weight constraints,

[1]Davis, C. L., London, H. S., and Tschirgi, J. M. - "The Common Space Fleet - A Brief Description" - Case 730, Bellcomm Memorandum For File, May 1, 1968.

[2]Macchia, D. - "Spacecraft Configuration Studies" - Case 730 Bellcomm Memorandum For File, April 25, 1968.

the operating environment, and lifetime considerations (Table 1). Other mission dependent requirements such as crew size, power level, experiment space, communications antenna and transmitter, etc. are to be met by assemblies of modular derivatives, or by the addition of mission peculiar modules or equipment. Satisfaction of the basic requirements provides a module that can support men over a wide operating environment and does not prevent adaptation to a variety of missions.

COMMON MODULE DERIVATIVES

A combined mission operations/living quarters module (Figure 1) is suitable for some missions but introduces weight, volume, and floor area penalties if used for other purposes. Observe that deletion of living quarters features, some control consoles, and the airlock would convert this module into a spacious experiment shell. Alternately, all control consoles could be deleted, thereby freeing space for additional crewmen. Obviously, the module volume has numerous potential uses. Engineering design and manufacturing planning could permit a number of different module types to be derived from a single basic module design.

Numerous module types or module derivatives are identified in Table 2. These derivatives are established by stages (or paths) of assembly. All modules have identical primary structure[1] (i.e., outer wall[2], pressure shell, insulation, and support structure); atmospheric and environmental control systems; and a power distribution network. At this point of assembly, the module is an empty shell with only the meteoroid shielding varying to suit the intended mission. Experiments could be housed in this empty shell with data handling services and power supplied by an adjoining module. As options, an experiment module can also include its own power source, primary spacecraft control, and mission control. This optional module assembly can separate mission operations from crew living space if an additional living quarters module is provided on the mission. The living quarters module would be derived form an empty shell by adding crew and life support systems (i.e., bunks, galley, hygiene areas, etc.), and a power source.

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[1]Johnson, C. E. - "Weight Estimates of Common Mission Module Structure" - Case 730, Bellcomm Memorandum For File, December 14, 1967.

[2]The outer sheet of the outer wall may vary in thickness or coating to provide different thermal and meteoroid protection.

Table 3 presents a more detailed listing of the subsystems which may be included in a common module. It may also be desirable to plan on subsystem options. For example, structural systems may or may not include circumferential docking mechanisms, or inter-module docking mechanisms. It is further noted that all structural, atmospheric, etc. subsystems are not necessarily installed sequentially as implied in Table 2. Manufacturing and testing convenience determine the optimum assembly path. For example, electrical harnesses would be installed at the same time, and large objects must be installed before closing the pressure shell.

The preceeding discussion explains some of the possible module types. Selection of the most desirable module types (and module size) cannot be uniquely done here since this depends on the intended missions and launch vehicles.

EXAMPLE MISSION USE

The common module defined herein would allow flexibility in mission scale and use. A single module, configured for mission control and living quarters, could support a lunar base or a specialized earth orbital mission (i.e., astronomy or earth resources). Two modules (one for living quarters and the other for mission control) could support a planetary mission. Several modules would satisfy the crew size and experiment space requirements of a large multi-disciplinary space station, (e.g., Saturn V launched space station).

Figure 2 illustrates a typical large space station assembled from three common modules. External experiments such as an astronomy facility and an earth sensor package are at opposite station ends and are accessible from the common modules. An unmanned satellite services hangar is also shown at the earth sensor station end. These external experiments are contained within launch vehicle interstage structures. The common modules at the station ends provide living quarters, primary spacecraft control, power, and external experiment control for the adjoining external experiments. Data handling and communications equipment could be in either end module (or duplicated). The center module is an experiment shell which taps power from the end modules. Module docking ports allow use of multiple logistics spacecraft and eliminate the need for a separate docking adapter. Note that experiment control is distributed between modules. (This avoids a special control module.)

The modular space station has several safety features. Primary spacecraft functions are duplicated in the end modules in addition to living quarters and power. In this way major module failures are isolated from other modules. A mission would be degraded (i.e., return or some crewmen, less power, shorter mission time, loss of some experiment control, etc.) but not aborted.

CONTINUING STUDIES

Common module weight and size parameters will be discussed in other papers. And finally, the ability of various size common modules to support a spectrum of manned missions will be examined. The intent of this effort is to illustrate the flexibility of a common module approach. Supporting studies which examine critical aspects of concept feasibility are also in progress or planned.

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TABLE 1

BASIC DESIGN REQUIREMENTS

SIZE AND WEIGHT CONSTRAINTS:

1. Module diameter shall be compatible with TIIIM, INT 20, INT 21, SIB, or SV launch vehicles. Maximum module dimensions will be established by TIIIM hammerheading limits or SLA packaging limits.

2. Module weight for at least a 2 man - 1 year lunar base is to be compatible with the landed lunar weight limit of a standard SV. An arbitrary payload in excess of 10,000 lbs. is to be included in the landed weight.

3. Module weight for at least a 2 man - 2 year orbital space station should not exceed the minimum payload capability of a TIIIM to low earth orbit. Preferably some payload margin for a manned launch, experiments and/or a propulsion module is desirable. To achieve these goals, expendable offloading may be considered.

OPERATIONAL ENVIRONMENT:

1. The common module shall operate in the environment between .5 and 2.0 A.U. of the sun. This environment includes earth, Mars, Venus, and lunar orbit and the lunar surface. Furthermore, it is desirable that the vehicle be capable of operation to .25 A.U. and through the asteroid belt for times and on trajectories dictated by particular missions.

2. The common module shall be capable of operation at any natural or induced gravity between zero and one earth gravity. This includes compatibility with spin mode operation.

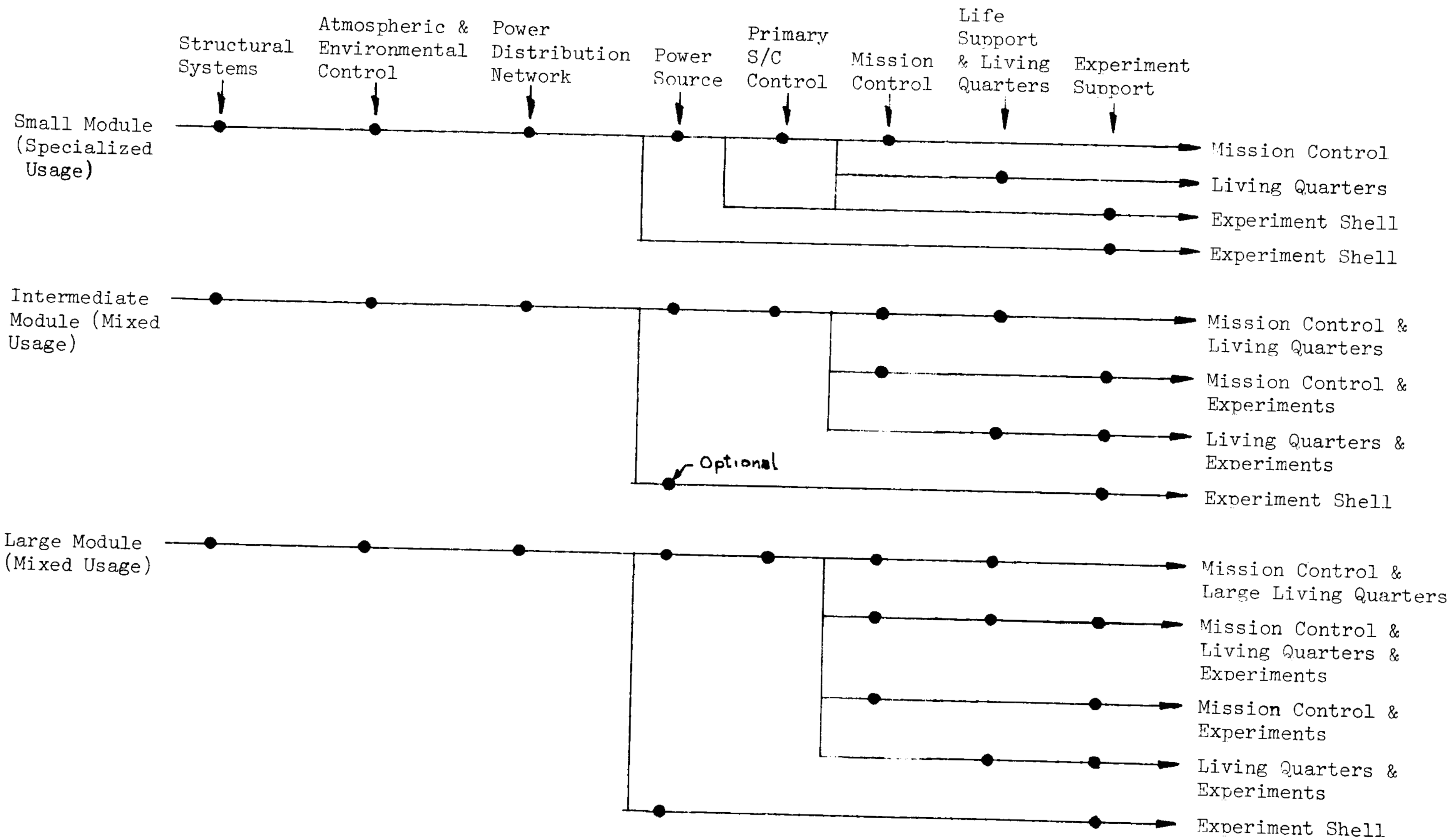
3. Guidance and navigation, communication, and data handling equipments should be adaptable for multiple mission use to minimize mission peculiar equipment.

LIFETIME CONSIDERATIONS:

1. The design lifetime for common module subsystems shall be at least 2 years.

2. The common module shall be capable of operation independent of external support for at least 2 years.

TABLE 2



Structural Systems
Atmospheric & Environmental Control
Power Distribution Network
Power Source
Primary S/C Control
Mission Control
Life Support & Living Quarters
Experiment Support
Small Module (Specialized Usage)
Mission Control
Living Quarters
Experiment Shell
Experiment Shell
Intermediate Module (Mixed Usage)
Mission Control & Living Quarters
Mission Control & Experiments
Living Quarters & Experiments
Optional
Experiment Shell
Large Module (Mixed Usage)
Mission Control & Large Living Quarters
Mission Control & Living Quarters & Experiments
Mission Control & Experiments
Living Quarters & Experiments
Experiment Shell

TABLE 3

(* = optional)

Structural Systems:

- outer wall (includes integral radiator, variable thickness meteoroid protection, and wall ports)
- pressurized internal shell (with wall ports and floor hatches)
- insulation
- support structure
- airlock*
- circumferential docking mechanisms*
- inter-module tunnels*
- inter-module docking mechanisms*
- inter-module tunnels for harnesses and power cable

Atmospheric and Environmental Control:

- ducting and fans
- atmospheric supply tankage and plumbing
- atmospheric regeneration equipment
- environmental control (and plumbing to outer wall radiators)
- instrumentation panel and harness (sensors and control)

Power Distribution:

- power distribution cable and taps
- inter-module power umbilical*

Power Source:

- isotope heat source and reentry vehicle (installed on launch pad)*
- power conversion units*
- conditioning units*
- thermal control (with plumbing to outer wall radiators)*

Table 3 (Continued)

peaking batteries*

instrumentation panel and harness (sensors and control)*

Primary Spacecraft Control:

minimum guidance and control (ability to control attitude)*

minimum communications to ground (low data rate or voice)*

inter-module communications*

inter-module subsystems control harness*

Mission Control:

data handling systems*

communications (high data rate)*

simulation center (critical crew skills)*

guidance and navigation*

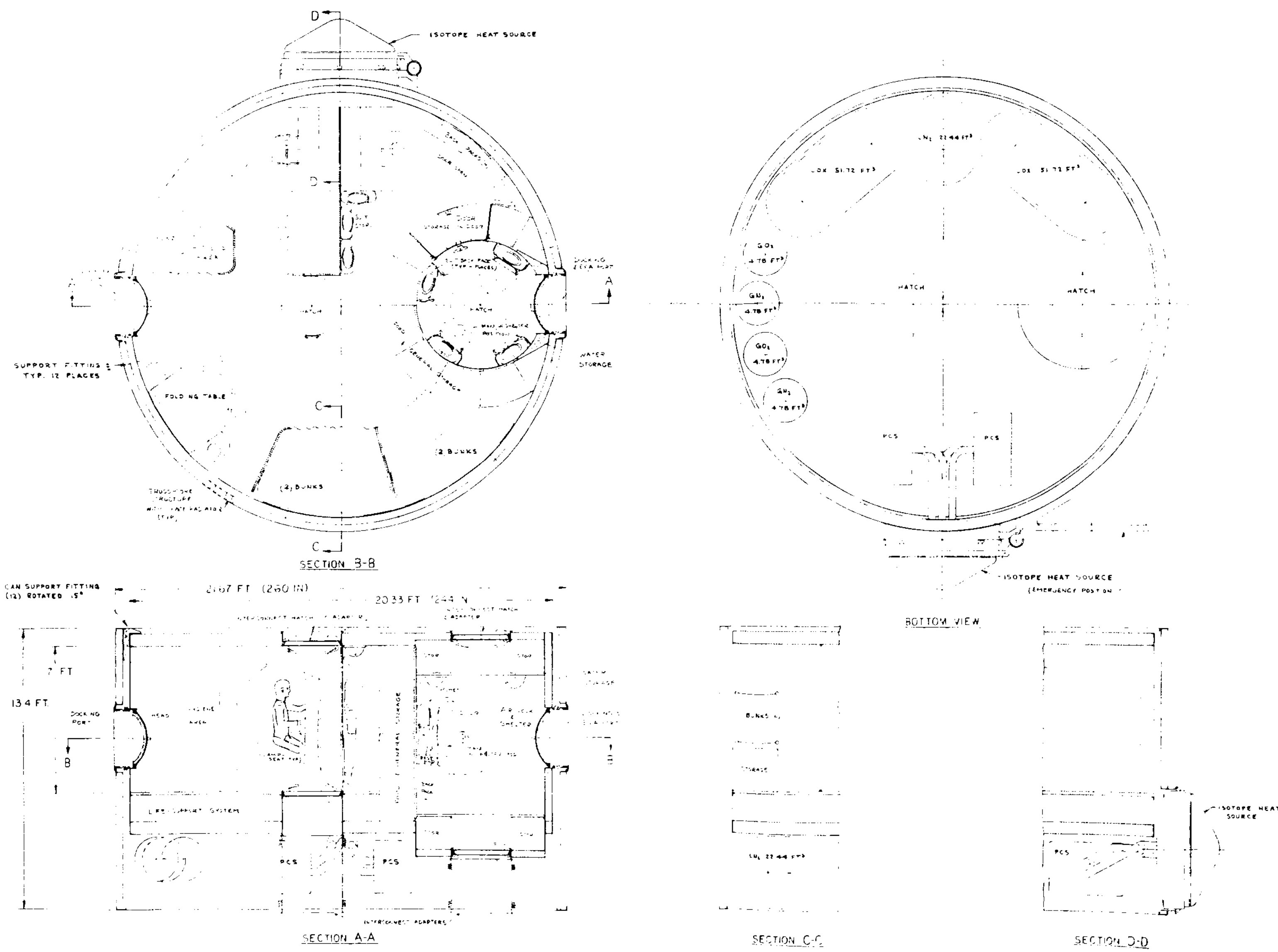
inter-module harnesses*

Experiment Support:

experiment control panels*

support structure and architectural modifications*

special provisions*



21.67 FT DIAMETER
4 MAN MODULE

SCALE: 1/20

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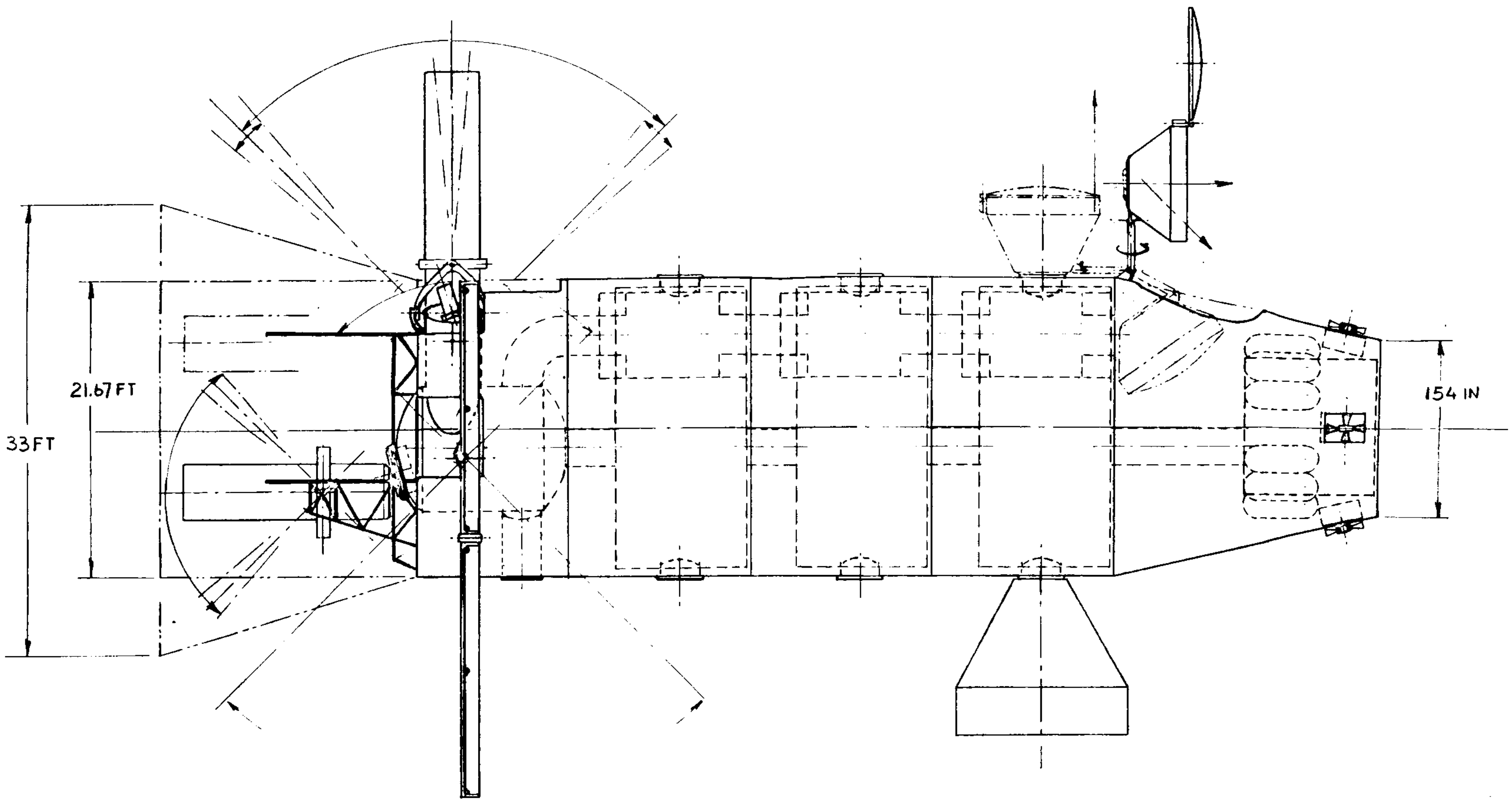
FIGURE 4



SPACE - STATION
21.67 FT MODULES

SCALE : 1/100 2-28-68

FIGURE ~~10~~ 2

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ERRATA

Figures 1 and 2 of "The Common Mission Module-Description and Use," Case 730, Bellcomm Memorandum for File, dated June 14, 1968 were incorrectly duplicated. The attached figures are forwarded for improved legibility.

D. Macchia

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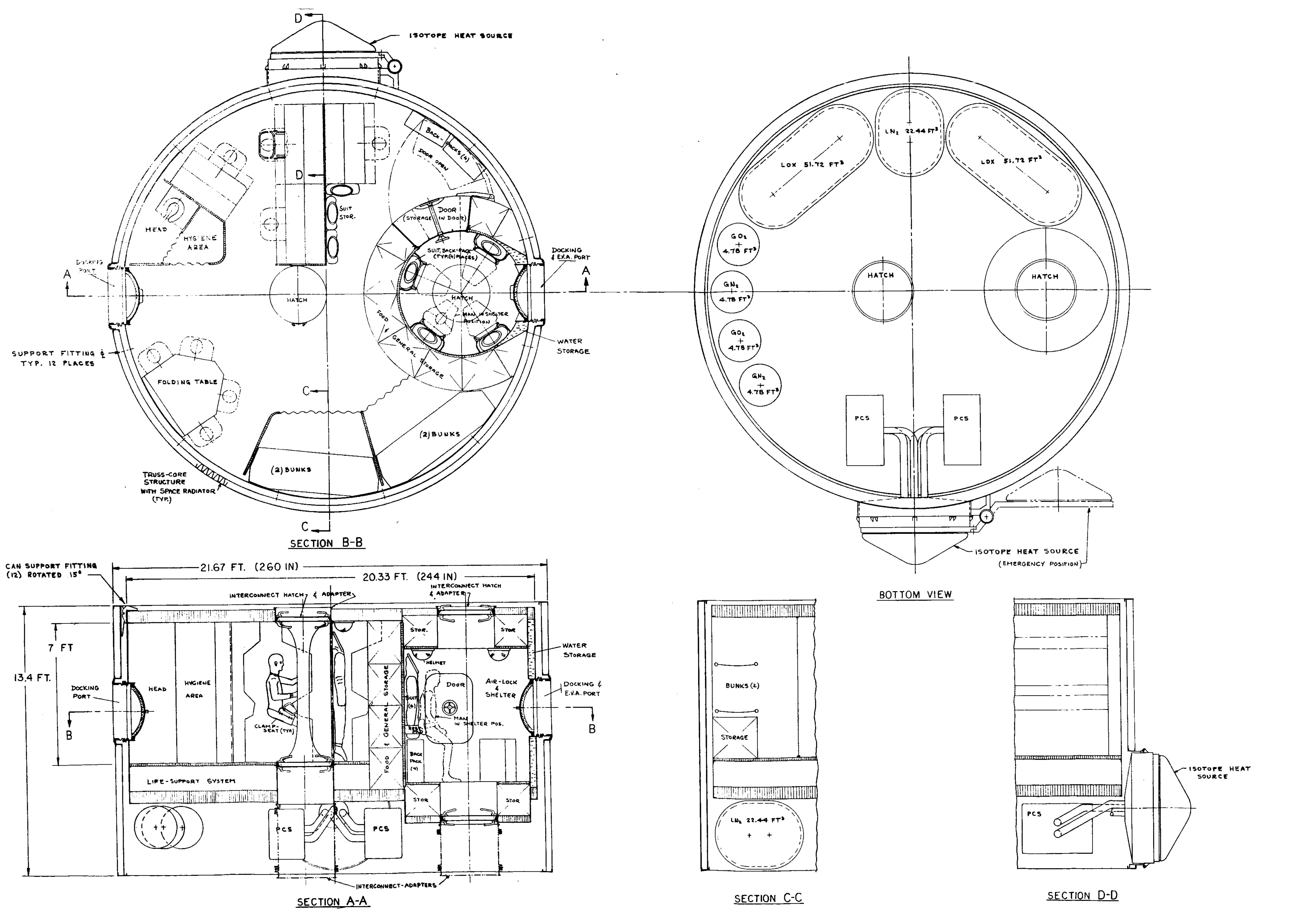
Attachments



21.67 FT. DIAMETER
4 MAN MODULE

SCALE: 1/20
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FIGURE 1

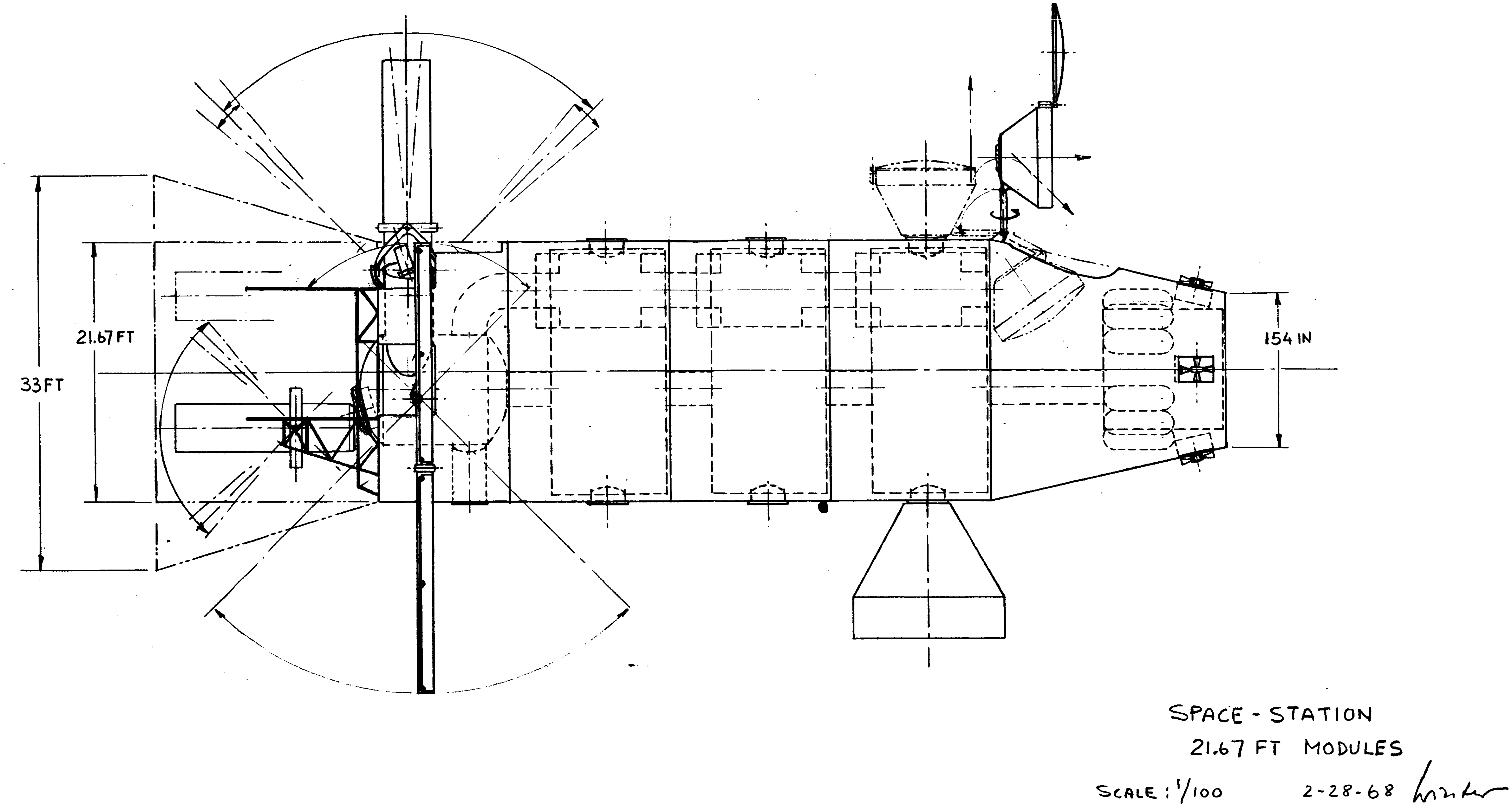
154 IN
21.67 FT
33 FT
SPACE - STATION
21.67 FT MODULES
SCALE : 1/100
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FIGURE 2